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EXAMINER	
DAHIMENE, MAHMOUD	
ART UNIT	**PAPER NUMBER**
1765	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/726,992	AVANZINO, STEVEN C.	
	Examiner	Art Unit	
	Mahmoud Dahimene	1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *03 October 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-20* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-20* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Response to Arguments/Amendment

Applicant's arguments, filed on 10/03/2005, with respect to the rejection(s) of claim(s) 1-3, 5, 7-11 and 16 under 35 U.S.C. 103 (a) have been fully considered and are persuasive. Therefore the rejection has been withdrawn. However, upon further consideration, the examiner changed his position/ground of rejection with regard to the statement of obviousness of the rejection over Uozumi (US 6261953) in view of Kondo et al. (US 6596638). A discussion of the rejection follows.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1,2,3,5,7,8,9,10,11,14 and16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Uozumi (US 6261953) in view of Kondo et al. (US 6596638)

Uozumi discloses a method for etching a copper film or structure, which reads on the claimed "the copper containing material comprising at least 10% by weight copper", the method comprises the steps of forming a copper oxide layer by contacting the

copper surface with an aqueous hydrogen peroxide containing solution, and then removing the copper oxide from the copper film using an acid containing solution (see column 4 line 7-14), the acid may be organic (column 5, line 15). The benefit of controlling the pH of the oxidizing solution is also addressed in the reference (figure 6).

A difference is noted between the applicant's claims and the reference of Uozumi. Uozumi's first solution comprises ammonia, hydrogen peroxide and water, whereas the applicant's first solution comprises a first organic acid, a peroxide compound and water.

Kondo at al. teach an abrasive free polishing method wherein copper is partially removed using a polishing solution comprising an oxidizer and a substance that renders the oxidized copper water soluble, in particular, a mixture of citric acid and aqueous hydrogen peroxide is cited as being a typical example of a polishing solution (column 5, line 22).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the process of Uozumi to replace the first solution with the solution of Kondo to provide a wider range of stability for the etch process, as illustrated by a progressive variation of etch rate versus pH (see Kondo, figure 26), and better control of the process. The sharp rise in etch rate versus pH for the ammonia-based solution in figure 6 of Uozumi is not desirable for process control.

Uozumi also differs from the claimed invention by using a second solution comprising an acid (which could be organic), instead of the applicant's second solution which comprises a organic acid (from list in claim 2) and water,

Kondo at al. teachings also include that organic acids are substances that render copper and copper oxide water soluble (column 6, line33, and column 12, line29).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the second solution of Uozumi to use an organic acid to render the byproduct of the first solution water soluble, because the reference of Kondo at al. illustrates how organic acids are used in controlled scratch free polishing of copper resulting in a smooth surface.

One of ordinary skill in the art would have been motivated to combine the teachings for a two-step method and the advantages of organic acids in order to obtain an abrasive free controllable copper etch method that provides scratch free smooth surfaces.

As to claims 3 and 5, another difference is noted between the teaching s of Uozumi and applicant's claimed invention.

Uozumi's method cited above is silent about the proportions or range of the components in solutions 1 and 2 as described by applicant's claims 3 and 5.

Kondo et al. describe a polishing solution with 30% aqueous H_2O_2, and 0.03 wt % citric acid (column 12, lines 32 and 48).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify Uozumi's solutions 1 and 2 to select the proper domain in the oxidation potential versus pH diagram as suggested by Kondo et al., in figures 9 and 26, to maximize oxidation by the first solution and optimum copper oxide removal by the second solution.

As to claim 7, another difference is noted between the teaching s of Uozumi and applicant's claimed invention.

Uozumi's method, cited abov,e fails to disclose a recommended range for the pH in the first solution specifically consisting of a peroxide compound, an organic acid and water, as the applicant's claim 7.

Kondo et al. disclose the corrosion rate of a polishing solution comprising a mixture of citric acid and aqueous hydrogen peroxide (figure 26, and column 5, line 22). Figure 26 shows that for the citric acid based solution, corrosion rate (etching rate) (column 5, line 17)) is higher when the pH of the solution is in the range of 1 to 6.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify Uozumi's solutions 1 and 2, as described above, to cover the range of pH where oxidation is maximized for solution 1, and copper oxide removal is optimized for solution 2.

As to claim 8, another difference is noted between the teaching s of Uozumi and applicant's claimed invention.

Uozumi's method cited above is silent about an operating temperature range for solutions 1 and 2 as applicant's claim 8 describes.

Kondo et al. disclose a polishing solution comprising a mixture of citric acid and aqueous hydrogen peroxide. For the cited example the temperature of the polishing solution was room temperature (column 12, line 37), which is included in the applicant's temperature range.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify Uozumi's solutions 1 and 2, as described earlier, to cover a temperature range where solutions 1 and 2 can be safely used avoiding slow etch rate if the temperature is too low and excessively high oxidation rate when the temperature is too high, resulting in rougher surfaces as described by Kondo et al.

As to claim 9, another difference is noted between the teaching s of Uozumi and applicant's claimed invention.

Uozumi's reference fails to specify oxide as a passivation layer.

Kondo et al. claim an oxide is formed when copper is contacted with a solution where the pH and oxidation-reduction potential are in the domain of corrosion of said metal (column 21, line 5).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify Uozumi and Kondo's method to include Cu oxide in the passivation because, as taught by Kondo oxide is formed when the pH of the solution and oxidation-reduction potential are in the domain of corrosion of copper.

As to claim 10, another difference is noted between the teaching s of Uozumi and applicant's claimed invention.

Uozumi discloses a method for etching a copper film or structure, which reads on the claimed "the copper containing material comprising at least 25% by weight copper", the method comprises the steps of forming a copper oxide layer by contacting the copper surface with an aqueous hydrogen peroxide containing solution, and then

removing the copper oxide from the copper film using an acid containing solution (see column 4 line 7-14), the acid may be organic (column 5, line 15). The benefit of controlling the pH of the oxidizing solution is also addressed in the reference (figure 6).

With respect to claim 10, a difference is noted between the applicant's claims and the reference of Uozumi. Uozumi's first solution comprises ammonia, hydrogen peroxide and water, whereas the applicant's first solution comprises a first organic acid, a peroxide compound and water.

Kondo at al. teach an abrasive free polishing method wherein copper is partially removed using a polishing solution comprising an oxidizer and a substance that renders the oxidized copper water soluble, in particular, a mixture of citric acid and aqueous hydrogen peroxide is cited as being a typical example of a polishing solution (column 5, line 22).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the process of Uozumi to substitute ammonia with an organic acid in the first solution to provide a wider range of stability for the etch process (see Kondo, figure 26) and better control of the etch process.

Uozumi also differs from the claimed invention by using a second solution comprising an acid (which could be organic), instead of the applicant's second solution which comprises a organic acid (from list in claim 2) and water,

Kondo et al. teachings also include that organic acids are substances that render copper and copper oxide water soluble (column 6, line33, and column 12, line29).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the second solution of Uozumi to use an organic acid to render the byproduct of the first solution water soluble, because the reference of Kondo at al. illustrates how organic acids are used in controlled scratch free polishing of copper resulting in a smooth surface.

In addition, and relative to applicant's claim 10, Uozumi fails to specify relative values for pH and temperature for solutions 1 and 2, however, he discloses that the copper etching rate depends on the solution pH (figure 6). Uozumi also discloses that too high corrosion (oxidation) in the first step results in rougher surface (column 2, line 60).

Kondo et al. teach that, for a citric acid-based solution, the corrosion rate increases with decreasing pH (figure 26).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify Uozumi's method to increase the pH of the first solution relative to the second in order to control the corrosion (oxidation) during the first step in order to obtain a smoother surface (the second solution does not rely corrosion to remove the oxide layer).

As for the temperature Uozumi teaches that during the oxidation step, high temperature results in rougher surface as the rate of oxidation increases in the first solution (column 2, line 62).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to use a lower temperature for the first solution, relative

to the second solution, to control corrosion in the first step in order to obtain a smoother surface.

As to claim 11, another difference is noted between the teaching s of Uozumi and applicant's claimed invention.

Uozumi's method cited above is silent about specific proportions of peroxide compound, organic acid, water, surfactant and pH adjuster.

Kondo et al. describe a polishing solution with 30% aqueous H_2O_2, and 0.03 wt % citric acid (column 12, lines 32 and 48) which is in the in the range of the applicant's claim 11 for the peroxide compound, organic acid, water.

Kondo et al. fail to teach specific proportions for surfactant and pH adjuster but they do illustrate the benefits of adjusting the pH (column 5, line 3) as well as the optional use of surfactants (column 9, line 4).

As a result, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to select the proper proportions of pH adjuster and surfactant to effectively control the solution properties in order to accomplish the desired etch results (smoothness), because it has been held that there is no invention where the difference in proportions is not critical and was ascertained by routine experimentation because the determination of workable ranges is not considered inventive. See In re Swain and Adams, 70 USPQ 412 (CPA 1946).

As to claim 14, another difference is noted between the teaching s of Uozumi and applicant's claimed invention.

Uozumi's method cited above fails to disclose a specific process time range for solutions 1 and 2 as applicant's claim 14 describes.

Kondo et al. disclose a polishing solution comprising a mixture of citric acid and aqueous hydrogen peroxide. The time cited for a specific example was 400 seconds, which is in the range specified in applicant's claim 14. In addition, oxidation and etching times depends on the initial thickness and the exact specification for the desired results.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to specify a time for oxidation based on desired results including thickness to be removed and smoothness (as disclosed by Kondo et al.), and a time for oxide removal based on the desired quality of the final etched surface.

As to claim 16, another difference is noted between the teaching s of Uozumi and applicant's claimed invention.

Uozumi's method cited above fails disclose specific R_{tm}

Kondo et al. describe a polishing solution with 30% aqueous H_2O_2, and 0.03 wt % citric acid (column 12, lines 32 and 48). Kondo et al. also fails to specify a surface R_{tm}. However Kondo et al. discuss critical parameters for obtaining a smooth surface.

As a result, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to select the proper parameters such as pH, temperature and oxidation time, to experimentally select the degree of smoothness as specified by other requirements.

3. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Uozumi (US 6261953) in view of Kondo et al. (US 6596638) and further in view of Miller (US 6719920).

Uozumi's method cited above fails to disclose specific proportions of organic acid, water, biocide and pH adjuster.

Kondo et al. describe a polishing solution with 30% aqueous H_2O_2, and 0.03 wt % citric acid (column 12, lines 32 and 48) which is in the in the range of the applicant's claim 12, for organic acid and water. Kondo et al. fail to teach specific proportions for biocide and pH adjuster but they do illustrate the benefits of adjusting the pH (column 5, line 3).

Miller discloses that the addition of biocides (column 4, line 15) may help eliminate, from a solution, organisms that could yield undesirable results, but does not specify the proportions to be used in the above solution.

As a result, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to select the proper proportions of pH adjuster and biocide to effectively control the solution properties in order to accomplish the desired etch results (smoothness) and an organism free solution, because it has been held that there is no invention where the difference in proportions is not critical and was ascertained by routine experimentation because the determination of workable ranges is not considered inventive. See In re Swain and Adams, 70 USPQ 412 (CPA 1946).

4. Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Uozumi (US 6261953) in view of Kondo et al. (US 6596638) and further in view of Shimazu et al. (US 6547843.

Uozumi's method has been described above. A difference is noted between the applicant's claim and the references of Uozumi and Kondo et al. both Uozumi and Kondo et al. references fails to include a second acid in the second solution.

Shimazu et al. disclose a copper polishing solution including at least one organic acid (e.g. acetic acid, citric acid, etc.) (column 5, line 21).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the process of Uozumi to include at least two organic acids to obtain a solution where the combined action of the acids yields a better copper etch by adjusting selectivity as different materials are used as dielectric isolation, also different acids have different reactions with different copper compounds. One of ordinary skill in the art would have been motivated to combine the teachings for a two-step method and the advantages of combining organic acids in order to obtain a smoother surface and control selectivity.

5. Claim17-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over over Uozumi (US 6261953) in view of Kondo et al. (US 6596638), and further in view of Singh at al. (US 6594024).

The references of Uozumi and Kondo et al. have been discussed above.

A difference is noted between the applicant's claims and the reference of Uozumi. and Kondo et al. wherein the disclosures do not include a monitoring or endpoint method.

Singh et al. teach a method for monitoring a CMP polishing process using scatterometry, the disclosed method includes comparing the signature (column 14, line 58) associated with removing a layer to a signature library (column 14, line 61) for terminating a process when the desired depth is attained as in applicant's claim 17.

Singh's method involves directing a beam of light at the processed layer and collecting a light reflected from the processed layer (column 3, line 50) and transforming the signal into a signature as in applicant's claim 18.

Singh's method also includes a closed loop feedback control system (column 14, line 63), and it is capable of endpoint functions (column 2, line 47) including layer profiles as in applicant's claims 19 and 20.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to incorporate Singh's control system into the modified teachings of Uozumi's method to allow for etch process control. Endpoint detection and control systems are commonly used in semiconductor etch, CMP, and deposition technologies.

6. Claims 4,6 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Uozumi as applied to claim 1,2,3,5,7,8,9,10,11,14 and16 above, and further in view of Kondo et al.

With respect to claims 4, 6 and 15, the modified teachings of Kondo are silent regarding the presence of surfactants, however, applicant admitted prior art specifically that surfactants are known in the art (Page 8, line 9).

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made modify Uozumi and Kondo's method to include surfactants in the solutions, because surfactants enhance surface reaction for etching and oxide removal. It would have been obvious to one skilled in the art to add a surfactant to the solutions to obtain a smoother surface.

Response to Applicant remarks filed on 10/03/2005

As discussed in paragraph 2 above, the obviousness statement to combine Uozumi and Kondo has been rewritten as "it would have been obvious to one of ordinary skill in the art at the time of the invention was made to modify the process of Uozumi to replace the first solution with the solution of Kondo to provide a wider range of stability for the etch process, as illustrated by a progressive variation of etch rate versus pH (see Kondo, figure 26), and better control of the process. The sharp rise in etch rate versus pH for the ammonia-based solution in figure 6 of Uozumi is not desirable for process control".

The examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references

themselves or in the knowledge generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988)and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). In this case, the examiner is not suggesting to modify the first solution of Uozumi, but to replace it with the solution of Kondo, namely a mixture of citric acid and aqueous hydrogen peroxide (column 5, line 22).

The Solution of Kondo comprises an oxidizer (aqueous hydrogen peroxide) and citric acid. The purpose of this solution is to oxidize (hydrogen peroxide oxidizes copper) and citric acid renders the copper oxide water soluble. The pH of 8-10 suggested by Uozumi is no longer applicable to the solution of Kondo which has a different range of operable parameters. One skilled in the art would have been motivated to replace the first solution of Uozumi by the solution of Kondo because Kondo clearly shows in figure 26 that corrosion rate (etch rate) is stable for a pH ranging from 1 to about 4.5 for which the corrosion rate (etch rate) varies by less than less than 10% whereas a variation of pH from 8 to 10 in the first solution of Uozumi will result in a variation of more than 70% in etch rate as illustrated by figure 6 of Uozumi. One skilled in the art would use the solution that yields the higher stability because it would require less stringent control over the pH to obtain reliable etch rate within the wafer and wafer-to-wafer as pH might change for any reason during process.

Figure 26 (and related figure 9) of Kondo does motivate one skilled in the art to replace the first solution of Uozumi with a more stable etch solution. If stability, etch rate and smoothness are the primary goals of the process, Kondo's solution is preferable.

Figure 26 (and related figure 9) of Kondo teaches that higher corrosion is obtained at lower pH, which is the partial etch mechanism used by Kondo's solution, the other mechanism being polishing action.

As to the second solution Uozumi teaches "Another way of etching copper is to oxidize a copper film and then remove the copper oxide using acid or the like." (column 2, line 45), and more specifically Uozumi recites " For example, Jpn. Pat. Appln. KOKAI Publication No. 2-306631 proposes a method of carrying out implantation of oxygen ions in a copper film and then annealing the resultant structure or subjecting the structure to an oxygen plasma treatment to form a copper oxide, and then etching the copper oxide with diluted sulfuric acid or acetic acid" (column 2, lines 47-53). Acetic acid is an organic acid listed in applicants claim 2.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Mahmoud Dahimene whose telephone number is (571) 272-2410. The examiner can normally be reached on week days from 8:00 AM. to 5:00 PM..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on (571) 272-1465. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Muahmoud Dahimene

MD

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